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**(54) PIEZOELECTRIC PERCELAIN COMPOSITION**

**(57) Abstract:**

**PROBLEM TO BE SOLVED:** To obtain a piezoelectric porcelain composition applicable for driving at high vibration frequency.

**SOLUTION:** Main component is expressed by a compositional formula  
 $a\text{PbZrO}_3\text{-}b\text{PbTiO}_3\text{-}c\text{Pb}(\text{Mn}_{1/3}\text{Nb}_{2/3})\text{O}_3$  (wherein

$a+b+c=1$ ). The component range is on the line connecting the component points and in an area surrounded by these four component points which are W ( $a=0.35$ ,  $b=0.60$ ,  $c=0.05$ ), X ( $a=0.60$ ,  $b=0.35$ ,  $c=0.05$ ), Y ( $a=0.25$ ,  $b=0.50$ ,  $c=0.25$ ) and Z ( $a=0.55$ ,  $b=0.20$ ,  $c=0.25$ ). 0.1-0.5 wt.%  $\text{La}_2\text{O}_3$  is contained as a subsidiary component in 100 wt.% of the main component.

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 CLAIMS
 

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[Claim(s)]

[Claim 1] A principal component is expressed with empirical formula  $a\text{PbZrO}_3\text{-}b\text{PbTiO}_3\text{-}c\text{Pb}(\text{Mn}^{1/3}\text{Nb}^{2/3})\text{O}_3$  (however,  $a+b+c=1$ ). The presentation range W ( $a=0.35$ ,  $b=0.60$ ,  $c=0.05$ ), X ( $a=0.60$ ,  $b=0.35$ ,  $c=0.05$ ), When it is expressed in the field surrounded by the line top which connects the forming point of Y ( $a=0.25$ ,  $b=0.50$ ,  $c=0.25$ ) and Z ( $a=0.55$ ,  $b=0.20$ ,  $c=0.25$ ), and these four points and a principal component is made into 100% by weight as an accessory constituent,  $\text{La}_2\text{O}_3$  -- 0.1 - 0.5wt% -- the piezoelectric-ceramics constituent characterized by containing.

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 DETAILED DESCRIPTION
 

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the piezoelectric-ceramics constituent which has the efficient electric machine transfer characteristic with a wide range vibration level especially about the piezoelectric material suitable for a piezoelectric transformer, an electrostrictive actuator, an ultrasonic vibrator, etc.

[0002]

[Description of the Prior Art] As for the piezoelectric material which can transform electrical energy into mechanical oscillation energy, the application to a piezoelectric transformer, an electrostrictive actuator, an ultrasonic vibrator, etc. is made. Piezoelectric material reaches far and wide from a small mechanical output to a very big mechanical output to these application according to the application, and is efficient, and it is called for that electric-mechanical energy conversion is performed. While the device adapting piezoelectric material is put in practical use in recent years, the further increase of the mechanical output is searched for.

[0003] Therefore, on the occasion of conversion to the mechanical vibrational energy of electrical energy, it is necessary [ it ] to these application to control energy loss for piezoelectric material. Since generation of heat by internal energy loss arises in connection with an amplitude of operation or a vibration level becoming high, the amplitude which can be excited soon will reach threshold value, i.e., vibration level threshold value, and will cause dielectric breakdown of an ingredient further. V is expressed with a degree type when a vibration level is now made into the effectual velocity of vibration V computable from measurement of maximum tip amplitude  $x_{im}$  of vibrator, and the resonance frequency  $f_r$  of vibrator.

[0004]  $V=2\pi f_r x_{im}$ , and  $\pi$ -fr- $x_{im}$  ... (1)

[0005] However, when a vibration level was expressed by the velocity of vibration, with the conventional technique, there was a problem that the limitation of the velocity of vibration which can be used in comfort was low.

[0006]

[Problem(s) to be Solved by the Invention] Since the conventional ingredient served as a drive by the low velocity of vibration as described above, the application to the device with which a big mechanical output is demanded was difficult.

[0007] This invention aims at offering the piezoelectric-ceramics constituent which can also drive the high velocity of vibration.

[0008]

[Means for Solving the Problem] this invention person found out the presentation

range and additive range of a piezoelectric-ceramics ingredient which can be driven also with a high vibration level (rate).

[0009] Namely, as for this invention, a principal component is expressed with empirical formula  $a\text{PbZrO}_3\text{-}b\text{PbTiO}_3\text{-}c\text{Pb}(\text{Mn}^{1/3}\text{Nb}^{2/3})\text{O}_3$  (however,  $a+b+c=1$ ). The presentation range W ( $a=0.35$ ,  $b=0.60$ ,  $c=0.05$ ), X ( $a=0.60$ ,  $b=0.35$ ,  $c=0.05$ ), When it is expressed in the field surrounded by the line top which connects the forming point of Y ( $a=0.25$ ,  $b=0.50$ ,  $c=0.25$ ) and Z ( $a=0.55$ ,  $b=0.20$ ,  $c=0.25$ ), and these four points and a principal component is made into 100% by weight as an accessory constituent,  $\text{La}_2\text{O}_3$  -- 0.1 - 0.5wt% -- it is the piezoelectric-ceramics constituent characterized by containing.

[0010] The piezoelectric-ceramics ingredient which has the vibration level limitation  $V_{\text{max}}$  higher than before by considering as the above-mentioned presentation range and above-mentioned additive range of this invention is obtained.

[0011]

[Embodiment of the Invention] The gestalt of operation of this invention is explained below.

[0012] As a start raw material which obtains the constituent of this invention, each powder of a lead oxide ( $\text{PbO}$ ), a zirconium dioxide ( $\text{ZrO}_2$ ), titanium oxide ( $\text{TiO}_2$ ), manganese carbonate ( $\text{MnCO}_3$ ), niobium oxide ( $\text{Nb}_2\text{O}_3$ ), and a lanthanum trioxide ( $\text{La}_2\text{O}_3$ ) was used.

[0013] Specified quantity weighing capacity of each raw material powder was carried out, and temporary quenching of the mixed powder was carried out in 2-hour atmospheric air at 850 degrees C after wet blending by the ball mill. After grinding temporary-quenching powder, it binder-mixed and fabricated, and further, the debinder was carried out and it calcinated in 2-hour atmospheric air at 1200-1265 degrees C. Next, after cutting the obtained sintered compact and processing it into a 43x7x1mm rectangle plate, the silver electrode could be burned on both the principal planes that carry out phase opposite, 4kV [mm] direct-current electric field were impressed among silicone oil at 100 degrees C for 15 minutes, and polarization processing was performed.

[0014] After polarization processing, room temperature neglect was carried out for 24 hours, the basic mode of the piezo-electric transversal-effect die-length direction vibration was excited, and the vibration level limitation was measured.

[0015] Temperature rise (difference of room temperature and temperature of vibrator)  $\Delta T$  excited by internal energy loss of the vibrator made the vibration level (rate) limitation the velocity of vibration which becomes 20 degrees C by the thermometry in the joint of vibration of a piezoelectric transducer.

[0016] A measurement result is shown in Table 1. In Table 1, mol% shows  $\text{PbZrO}_3$  amount,  $\text{PbTiO}_3$  amount, and  $\text{Pb}(\text{Mn}^{1/3}\text{Nb}^{2/3})\text{O}_3$  amount. Moreover, it is shown that the sample which \* described is a sample besides the generic claim of this invention.

[0017]

[Table 1]

試料 No.	PbZrO <sub>3</sub> 量 a	PbTiO <sub>3</sub> 量 b	Pb(Mn <sub>1/3</sub> Nb <sub>2/3</sub> )O <sub>3</sub> 量 c	La <sub>2</sub> O <sub>3</sub> 量 (wt%)	振動レベル限界 (単位: m/s)
1*	35	60	5	0	0.25
2	35	60	5	0.2	0.41
3	35	60	5	0.3	0.46
4*	60	35	5	0	0.40
5	60	35	5	0.1	0.45
6	60	35	5	0.3	0.50
7*	45	40	15	0	0.53
8	45	40	15	0.3	0.55
9	45	40	15	0.5	0.57
10*	35	50	15	0	0.47
11	35	50	15	0.1	0.49
12	35	50	15	0.3	0.53
13	35	50	15	0.5	0.55
14*	25	50	25	0	0.36
15	25	50	25	0.1	0.40
16	25	50	25	0.3	0.48
17	25	50	25	0.5	0.49
18*	25	50	25	1.0	0.39
19*	55	20	25	0	0.42
20	55	20	25	0.3	0.48
21	55	20	25	0.5	0.51

[0018] Next, based on Table 1, the reason which limited the rate of a compounding ratio of each compound (presentation ratio) is explained below. [0019] Since loss by internal friction accompanying movement of a ferroelectric domain wall is large when the amount c of Pb(Mn<sub>1/3</sub>Nb<sub>2/3</sub>)O<sub>3</sub> is less than [ 5mol% ], a vibration level limitation is low. Moreover, if 25-mol% is exceeded, unusual appearances, such as pyrochlore, will generate and elastic loss will be caused. Moreover, if the rate of a compounding ratio of the amount a of PbZrO<sub>3</sub> is made into the ratio besides a generic claim, since the capacity to transform electric energy into mechanical energy will fall extremely, a vibration level limitation becomes low. The amount b of PbTiO<sub>3</sub> will be inevitably decided, if a and c are decided. 20La<sub>3</sub> amount is desirable out of a generic claim by neither the fall of the effectiveness, nor change of the degree of sintering of an ingredient. Therefore, it is limited to presentation within the limits which that a vibration level limitation becomes larger than before charged.

[0020]

[Effect of the Invention] As explained above, according to this invention, the piezoelectric-ceramics constituent which can be driven also with the velocity of vibration conventionally higher than an ingredient or the large amplitude was able to be offered.

[0021] Therefore, it becomes applicable to the piezo-electric device vibrated with a high vibration level or the large amplitude, and industrial value is size.